tween the two peoples; and for the increase and diffusion of knowledge among men." It is apparently intended to accomplish this purpose by establishing an American college in China, and the resolution of the Association "heartily endorses the purpose of the aforesaid Bill."

In expatiating upon the propriety of this resolution, President Smith alluded to the insecurity of the present position of the fund in the hands of the United States Government, since it offered a premium for trumped-up claims, and already 37,000 dols. had been thus abstracted from it; that if it remained much longer unappropriated, Japanese as well as Chinese claims would be introduced against it, and it might eventually suffer the fate of the Smithsonian funds, which the Government had to make good after the loss of a considerable portion.

During the course of the same day a scene of intense excitement and disorder took place on the reading of a paper by Prof. B. C. Swallow, the Missouri geologist, entitled "Good Wine a Social and National Blessing,' which was devoted principally to the details of wine making. It was, however, made an opportunity for the discussion of the causes of drunkenness, and the best means for preventing it, which had far more of a social than of a scientific interest.

A very interesting and valuable paper was that of Mr. C. V. Riley of St. Louis, entitled "Insects Shaped by the Needs of Flowers," with especial reference to the fructification of the American Yuccas. Dr. Engleman of St. Louis had this year discovered that these plants must needs rely on some artificial agency for fertilisation. The flowers are peculiarly constructed, so that it is impossible for the pollen to reach the stigma, it being glutinous and expelled from the anthers before the blossoms open. Prof. Riley discovered that there was a small white moth that did the work, and demonstrated on the blackboard how wonderfully well the insect was adapted to the purpose. This little moth, which he calls *Pronuba Yuccasella*, has been unknown to entomologists, and forms the type of a new genus. It is most anomalous from the fact that the female only has the basal joint of the maxillary palpus wonderfully modified into a long prehensile-spined tentacle. With this tentacle she collects the pollen and thrusts it into the stigmatic tube, and after having thus fertilised the flower she consigns a few eggs to the young fruit, the seeds of which her larvæ feed upon. He stated that the Yucca was the only entomophilous plant known which absolutely depended for fertilisation on a single species of insect, and that insect so remarkably modified for the purpose. There was a beautiful adaptation of means to an end, and a mutual interdependence between the plant and animal; and Mr. Riley explained how on Darwinian grounds, even this perfect adaptation was doubtless brought about by slow degrees. He alluded, in closing, to a practical phase of the subject. The plant and its fructifier are inseparable, under natural conditions, and the latter occurs throughout the native home of the former. In the more northern portions of the United States, and in Europe, where our Yuccas have been introduced and are cultivated for their showy blossoms, the insect does not exist, and consequently the Yuccas never produce seed there. The larva of *Pronuba* eats through the Yucca capsule in which it fed, enters the ground and hibernates there in an oval silken cocoon. In this stage the insect may easily be sent by mail from one part of the world to another, and our transatlantic florists may by introducing it soon have the satisfaction of seeing their American Yuccas produce seed without any personal effort on their part.

Among other papers read at subsequent meetings of the Association was one by Dr. J. W. Foster on the "Bird-shaped Skulls found in Indian Mounds," in which he tried to show that the peculiar shape of these skulls was not produced by compression, as in the case with the heads of many modern Indian tribes, but really belonged to a very early and comparatively low type of man intellectually.

Another paper was by Prof. Daniel Kirkwood on "Binary Stars with Extraordinary Orbits," with special reference to Mr. Wilson's communication to the Royal Astronomical Society, as to the orbits of the stars constituting Castor.

Mr. W. W. Wheildon of Concord, Mass., advanced in opposition to what is known as the Gulf Stream theory an atmospheric theory to account for ameliorations of climate and an open sea in Polar regions. He thought that there could be no question that if the whole Arctic region were of open water that fact would not account for all the atmospheric phenomena and warmth of temperature experienced by polar navigators. The theory of Prof. Wheildon is that open water, melting ice, rain after snow, and other phenomena of the sort in Arctic regions, are not caused by winds warmed by an open sea, but by a circulation of air in which warm winds descend from upper atmospheres; being a circulation by which winds heated at the equator reach the poles. The brief discussion which followed this paper did not indicate much difference of opinion on the subject.

Of course, there were the usual numbers of excursions to places of interest, including one to the curious "Picture" or "Calico" Rocks near the town of Macgregor, which are composed of Potsdam sandstone. Far up in a narrow glen, outcropping sandstone rocks, partially denuded, exhibit in narrow stripes and patches, but principally in linear horizontal directions, the greatest variety of colours. Red is predominant, but black, blue, yellow, and intermediate shades are not wanting, each being distinct and not unfrequently contrasting sharply with the adjoining stripe, or with a gray that is almost white. Probably the original sand was white; the colours indicate varying admixtures of iron oxides and carbonates. Another was to the Mississippi, apparently for the purpose of seeing and collecting specimens of the large lily or lotus of that river (the *Nelumbium luteum*), closely allied to the Egyptian lotus. The last excursion was to Sioux City, and was to last for three days.

Altogether this year's meeting seems to have given general satisfaction, and the hospitality of the Iowans was unbounded. Next year's meeting is to take place at Portland, Maine, on the third Wednesday of August, Prof. Joseph Livesing, of Harvard University, being the president-elect.

THE FRENCH ASSOCIATION MEETING AT BORDEAUX

THE first session of the French Association for the Promotion of Science, closely modelled after that at Britain, was held at Bordeaux from the 5th to the 12th of September, and seems in all respects to have been successful and satisfactory. As is usual at similar meetings everywhere, the citizens of Bordeaux lavished their hospitality upon the members, who well deserved this as well as the gratitude of the French generally for inaugurating a movement to spread among that nation a knowledge of and love for science, and thus inform and temper their often misleading enthusiasm; in the words of M. Quatrefages, "to renovate our country by the scientific spirit and scientific studies." The meetings were well attended both by French and foreign *savans*, though the only two English ones whose names we notice were Prof. Odling and Dr. Gladstone. The Society already numbers 800 members, and, as will be seen by M. G. Masson's paper, its finances are in a flourishing condition. The first general meeting was presided over by M. de Quatrefages (the president-elect for next year), in room of M. Claude Bernard, the state of whose health prevented him from attending.

The opening address of M. de Quatrefages, as acting president, was a very stirring and noble one, full of sound sense as to the recent humiliation and present condition of France, enthusiasm towards science, and faith in it as one of the most powerful regenerators of the country. "Science is at present supreme," he said; "she is becoming more and more the sovereign of the world;" and he believes that it is only when all ranks and classes of the people, rulers and ruled, are thoroughly imbued with the scientific spirit, and are guided by scientific knowledge, that France will ever again take and maintain the supreme place in the world which she ought to hold. M. de Quatrefages concluded with a graceful allusion to "our elder sister, the British Association."

After an enthusiastic speech from the Mayor of Bordeaux, M. Cornu gave a brief sketch of the history of the Association. The first idea of the Association, he tells us, originated among a group of French Alsatian students gathered around M. Combes, the late lamented director of the School of Mines of Paris, and it has been nourished by a patriotic desire to contribute to the moral condition of the dejected country. After the death of M.

Combes, M. d'Eichtal came to the assistance of the embryo association, and on January 17 of this year a provisional council was appointed, with M. C. Bernard as president, and on April 22 the French Association was constituted, and already numbers upwards of 700 members. The British Association when it started in 1831 had only 370 members, whereas now it numbers many thousands, and can spend 2,000*l.* yearly for the progress of science. M. Cornu hopes that the French Association may become similarly prosperous, as indeed it seems to bid fair to do, for already, as M. Georges Massen, the treasurer, intimated, it has a capital of 140,000 francs, and can dispose of an annual revenue of 16,000 francs.

M. Laussedat gave an interesting lecture on "The Services which Modern Science can render to the Art of War," in which the starting sentence is that "Germany triumphed over France by numbers, discipline, and science." This was followed by a paper from M. Le Fort, on the Reform of Military Surgery. In the meetings of sections which followed, medical subjects received permanent attention, and called forth many papers of great value.

In the Anthropological Section, M. Lagneau read a careful paper on "The Ethnology of the Populations of the south-west of France, particularly of the basin of the Garonne and its affluents," M. Paul Lopenard one on "Prognathism," in which he gave some new measurements, and described a new method of measuring skulls; M. Parrot gave some details of the Cave of Excideuil (Dordogne), the variety of bones and other remains in which are of the greatest interest to anthropologists. Most of the other papers in this section were on subjects similar to the last, the prehistoric remains of various kinds found in caves, dolmens, &c., a department of Archæology to which much more has been done in France than in this country. M. Cartailhac went the length of saying that two populations belonging to prehistoric times could be distinguished as inhabiting the south of France; one warlike and given to the chase, who knew the beds of flint, and could cut it to perfection, and which was armed with the bow; the other pastoral, seldom feeding on wild animals, ignorant of the arrow and the flint weapon, and which used quartz, ophites, and other stones, but seldom flint for making axes.

But little seems to have been done in the Botanical section, one of the most valuable papers having been that of M. Van Tieghem, expounding the result of his researches into "Germination," which had for their object to determine experimentally the connection existing between the various organs of the embryo, and the degree of dependence of the latter upon the albumen. Another elaborate paper was by M. Baillon, "On the Floral Organisation of the *Amentaceæ*, and especially the Hazel."

Some of the most valuable and interesting papers of the meeting were read in the Section of Physics; the first, and one of the most attractive, was by M. A. Lallemand, President of the Section, "On the Polarisation and Colouration of the Atmosphere." The researches of M. Lallemand have been conducted on the basis of a theory which explains at once the origin of aërial polarisation, the formation of the neutral points indicated by Arago and Babinet, and the blue colour of the atmosphere. According to him, atmospheric illumination is only a particular instance of the phenomena of illumination of transparent bodies by a pencil of non-polarised solar rays. The generation of neutral points is explained simply by the intervention of the dust and atmospheric corpuscles which abound in the lower layers of the atmosphere, in the centre of which the observer finds himself placed. This paper was followed by another by M. Soret, of Geneva, "On the Influence of the Atmosphere upon the Intensity of Solar Radiation." The new experiments of M. Soret have been made by means of two calorimeters made upon the same principle and of analogous construction. The first, which is described under the name of "Actinomètre Transportable," is of small size, and consists simply of a metallic tube open at one end surrounded by a second concentric envelope. The interval between the two is filled with ice. At the bottom of the tube is fixed a thermometer, whose stem crosses the two envelopes, and upon which the sun's rays are allowed to fall. The thermometer, zero at the outset, rises in proportion as the quantity of heat which it receives equals that which it loses by radiation. The temperature which it finally reaches enables us to deduce the intensity of the solar radiation, after a certain number of corrections, the principal of which relate to barometric pressure. The Fixed Actinometer differs from the preceding only in its greater size, which allows of four thermometers being used instead of one: the inclosed interval is maintained at a constant temperature by a current of water. The experiments made by means of these instruments have enabled M. Soret to ascertain, in the first place, that the more moisture there is in the air, the less is the intensity of solar radiation for the same height of the sun and the same atmospheric pressure.

In the same section, M. Cornu presented a detailed sketch of the dark rays in the ultra-violet part of the solar spectrum, following the scale of the wave-lengths adopted by M. Angström in his memoir on the normal spectrum of the sun. These sketches have been made from the micrometric measurement to the microscope of photographic plates, forming two series. The first series has been obtained with the assistance of Nobert's network (of 1801 lines), of which the second spectrum was very perfect and very luminous; the proof obtained contained the rays G, H_1, H_2, L, M, N, O, P, and even Q, although the object glasses of Gonionde were of crown and flint glass. M. Cornu has verified the correctness of the measures of M. Mascart; the comparison of the results has always shown four common figures in the numerical expression of the wave-lengths. The second series, intended to furnish details of the rays of the photograph, proceed from a spectrum much dispersed and of great delicacy; more than twenty-five were counted between the two rays H_1 H_2. This spectrum was obtained with a flint prism of 60°; the moist collodion had taken an impression even up to the ray O, in spite of the absorbing power of the two object-glasses. M. Cornu strongly recommends the use of these ordinary achromatic object-glasses for obtaining photographs of the ultra-violet region, when it is desired to go no farther than ray O; the inconvenience of the absorbing power is largely compensated for by the ease of setting in position and by the angular size of the region where the lines are clearly distinguished. With regard to the process itself, it differs but little from that of M. Mascart. M. Cornu, however, advises the adoption of a small dark chamber exterior to the telescope, in place of the photographic camera of M. Mascart. The advantage of employing collodionised surfaces sufficiently large to make room for the spots and other defects, arises from the thinness of the plate. M. Cornu further indicates upon his sketches the principal lines of magnesium, lime, manganese, and iron, which, as is known, compose the greater part of the groups, L, M, and N.

M. Saint-Loup followed with a paper on a proposed modification of Holz's machine. Other papers of interest in this department were by M. Potier on "The Elliptical Polarisation produced by Vitreous Reflection;" by M. Petit on a Modification of the Ordinary Telegraphic System, by means of which the telegraph may be made to print directly; M. Descloizeaux a very curious paper on some of the Optical Phenomena of Crystals; and M. Gariel on the Distribution of Magnetism in Magnets.

In the Chemical Section, presided over by M. Balard, M. Berthelot read a paper of considerable practical value "On the State of Bodies held in Solution," in which he brought much discrimination and research to bear upon some of the ordinary problems of Chemistry, especially upon molecular mechanics. Other papers in this section were by M. Jungfleisch "On the Transformation of Tartaric Acid into Racemic Acid," and by M. Filhol "On the Nature of the Sulphuric Composition of the Mineral Waters of the Pyrenees."

In the Section of Zoology, under M. Soubeiran, various interesting papers were read, including one by M. Chatin, "On the Odoriferous Glands of some Mammiferous Animals;" one by M. Jobert, "On the Organs of Touch in Fishes;" one of considerable interest by M. Soubeiran, on the Oyster Culture at Arcachon; and one by M. Pouchet on the Colourisation of Fishes.

The Geological Section was presided over by M. Raulin, Professor at the Faculty of Sciences at Bordeaux, and in the section devoted to Mathematics, Astronomy, Geodesy, and Mechanics a paper was read by Madame Hureau de Villeneuve "On the Mechanism of the Flying Apparatus of Birds." She was preceded by M. Respighi, who read an able paper on the Scintillation of Stars. In accordance with a long series of observations made by him, he showed that the changes in brightness and colour presented by stars near the horizon are caused by momentary and successive deviations of luminous rays of different colours, by which these rays are carried outside of the object-glass of the telescope or the eye of the observer. These deviations are produced by extraordinary refractions or irregularities in layers of air condensed or rarified, placed at great distance from the observer, and at the precise spot where by atmospheric dispersion the rays of the different colours directed by the object-glass are separated from one another, so as to be only partly contained in the irregularly refracting layers of air. The most important result of M. Respighi's observations is this:—the layers of heterogeneous air are not reached by the luminous rays of different colours by means of the internal movement of atmospheric masses, but by their general movement caused by the rotation of the earth; which shows that the rotation of the earth is one of the principal elements in causing the twinkling of the stars. M. Respighi next described a very ingenious zenith telescope by means of which he can obtain the zenith distance of stars in their passage across the meridian.

In the Section of Geography, Political Economy and Statistics, various papers were read on methods of education.

The first session of the Association lasted eight full days, during which excursions were made to Arcachon, and to the Troglodyte Caves of Eyzies. On the condition and civilisation of the people whose remains they contain, M. Broca gave a very interesting lecture, in which he concluded that these men were savages, but in a state of partial civilisation, having at their disposal abundant food, and consequently leisure, applying themselves to the arts, and already exhibiting the perfectibility of the race. Another excursion was made to the Pointe de Grave, and one, which lasted three days, to the Industrial and Scientific establishment of Landes as far as Bidassoa. The Monday, Wednesday, Thursday, and Friday were devoted to *séances*, the morning for the sections, and the afternoons for general meetings. These public meetings were well attended, especially the evening lectures of MM. Broca and Cornu, who had audiences numbering about 800. Much interest was also manifested in the narratives of MM. Janssen and Respighi, who recounted the results of their researches into the constitution of the sun, and of their visit to India last year.

The reports of the Congress speak in lavish terms of the hospitality and considerateness in all respects of the Bordelais, whose city seems to be one of the foremost in France in respect of educational and scientific institutions. There can be no doubt about the success on the whole of the first meeting of the French Association; and we only hope that by the time it re-assembles at Lyons next year it will have advanced to the same ratio as it has done from its foundation till now, and that ere very long it will have taken as firm root as a recognised and universally beneficial French institution, as the British Association has done among ourselves.

*ON PULSE FREQUENCY AND THE FORCES WHICH VARY IT**

THE circulation of the blood is an uniform circulation, the pulsations being neglected, and a uniform circulation is one in which the quantity of fluid flowing through all segments of the circulating system is the same; otherwise there would be a tendency for the fluid to accumulate at certain points, which is contrary to the premises.

To arrive at precise conclusions respecting the circulation there are two points which must be considered—1st., The laws which regulate the flow of fluids through capillary tubes. 2nd., The variations in the capacity of the circulating system under different pressures. These will be considered separately. Poiseuille found that the flow of fluids through capillary tubes varies directly as the pressure and as the fourth power of the diameter of the tubes. The author has verified the former of these results on the vessels of the animal system by a different method. Respecting the capacity of the arteries and ventricles under different blood pressures, it is evident that the capacity of the former must depend on the pressure only, for they are simple elastic tubes, and must be more capacious under high than under low pressures; reasons are given below for a more precise statement of this relation. To maintain a uniform circulation with a pulsating motor, like the heart, it is evident from the above considerations that variations in the resistance at the small arteries must produce variations in pulse-rate; and that unless the capacity of the arteries and heart vary directly as the pressure, variations in blood pressure must be also attended with change in pulse frequency. That the capacity of the ventricles is dependent on the arterial blood pressure can be proved by the varied amount of opening up of the ventricular cavities which follows different fluid pressures in the coronary arteries.

Next, the different forces which vary the pulse-rate must be considered. It can be shown that any change in the resistance to the flow of blood through the capillaries varies the pulse-rate, increased resistance rendering the pulse slower and the reverse. As instances of these effects may be given, the pulse-slowing effects of stripping in a cold air, of a cold bath, and of compression of large arteries; the pulse-quickening effects of a hot bath, whether air or water. Numerous experiments by the author prove that the effect of copious blood-letting is not to modify the pulse-rate at all, thus showing that the law given by Marey respecting pulse frequency is not correctly based. The above points, namely the law of Poiseuille, the dependence of the capacity of the arteries and ventricles on the pressure of the blood, the dependence of the pulse-rate on the peripheral resistance and its non-dependence on the blood pressure, can all be correlated by only one theory, namely, that the heart always re-commences to beat when the tension or pressure in the arteries has fallen at invariable proportions, which also assumes that the capacity of the heart and arteries varies directly as the pressure. The facts that the arteries are generally empty after death, and that the cavity of the heart is sometimes found to be obliterated on *rigor mortis*, show that absence of pressure and capacity go together.

This theory explains the known peculiarities in pulse rate attending change in position, by showing that while standing all the pressure of the body weight is borne by non-compressible rigid tissues and so the circulation is normal, but while lying, the soft parts are compressed and resistance introduced into the circulation, reducing the rapidity of tension-fall, and therefore the frequency of the pulse; an intermediate condition attends the sitting posture. The pulse quickens during inspiration, and becomes slower during expiration; for during the former act the reducing pressure in the chest lowers the aortic blood pressure, and makes the tension-fall more rapid, while in expiration the reverse occurs.

This theory also is the only one which throws light on the cardiograph law published by the author (see *Journal of Anatomy and Physiology*, 1870–73), which may be thus stated —For any given pulse-rate the first part of the heart's revolution has a constant length, but it varies as the square root of the length of the complete pulsation. The pulse-rate not depending on the blood pressure, and the length of the first cardiac interval not varying when the rate is constant, its length also does not depend on the blood pressure. The first cardiac interval may be divided into the systole and the interval between that and the closure of the aortic valve (the diaspasis); these combined not varying as the blood pressure, it is almost certain that separately they do not do so either; so it may be said that neither the length of the systole nor of the diaspasis depends on the blood pressure. But the fall of tension between the pulse beats being but small, and the diaspasis length not depending on the blood pressure, there is no reason why it should vary in length with different pulse-rates; and assuming this in connection with the measured diaspasis length in a particular case (·00183 of a minute), it can be deducted from the above cardiograph law, that the systolic length varies as the square root of the diastolic. From these facts the relation of the nutrition of the heart to the time of heart nutrition (diastole); and to the blood pressure, may be deduced; for the systolic length not varying with the blood pressure when the pulse rate is constant it is evident that the cardiac nutrition must vary directly as the blood pressure in the aorta; and the systole varying as the square root of the diastolic time, shews that the nutrition of the heart varies as the square of the time of nutrition (diastole), for with a quadruple resistance to the peripheral circulation, the heart would be four times

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* Paper read before the British Association at Brighton in Section D, Department of Anatomy and Physiology,) by A. H. Garrod.